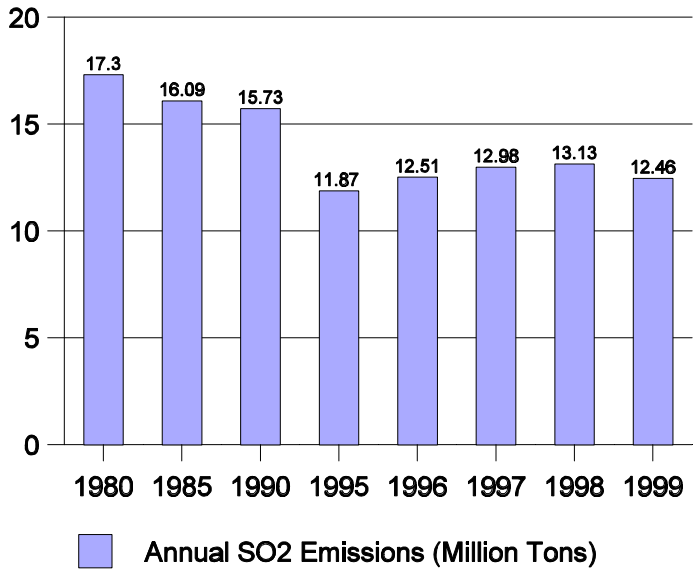
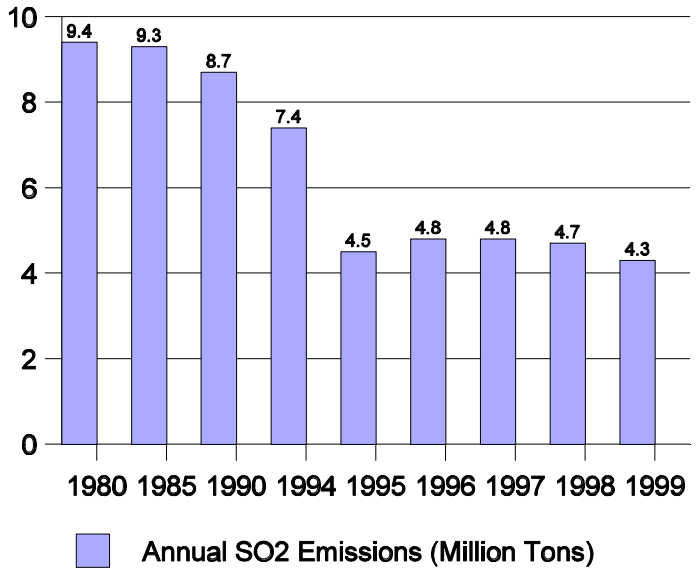
Figure 1. *National SO_2 Emissions Trend for all Title IV Affected Units*



The long term trend in SO_2 mass emissions for all units affected under Title IV is shown in Figure 1 (the data are displayed at five-year intervals from 1980 to 1995, followed by 1996, 1997, 1998, and 1999). Emissions declined gradually by 9.1% or about 1.6 million tons between 1980 and 1990, followed by a sharp drop of about 24.5% or 3.9 million tons from 1990 to 1995, which was the first year Phase I units were required to comply with the Acid Rain Program. This emissions drop was then followed by increases of approximately 5.7% or 670,000 tons in 1996, 3.8% or 470,000 tons in 1997 and 1.2% or 150,000 tons in 1998. Finally, in 1999 emissions dropped approximately 5.1% or 670,000 tons.

Figure 2. *Phase I, Table 1 Unit SO_2 Emissions Trend*



Note: Seven Phase I, Table 1 units (out of 263 units) are retired and have no emissions.

Figure 2 shows the SO_2 emissions trend for the 263 units required to participate in Phase I of the program ("Table 1" units) over the same time period (including data from 1994). For 1995 through 1999, SO_2 emissions for Table 1 units fell below their allowable level for each year. In 1995, the Table 1 units emitted 3.0 million tons less than the allowable level for 1995 (7.4 million tons). In 1996, the Table 1 units emitted 2.4 million tons less than the 1996 allowable level of 7.1 million tons. The 1997 emissions for Table 1 units were 1.3 million tons below the allowable level of 6.1 million tons. In 1998 and 1999 the allowable level was 6.0 million tons and for each year Table I units emitted 1.3 and 1.6 million tons, repectively, less than the allowable level.

Figure 3. *National Heat Input Trend for all Title IV Affected Units*

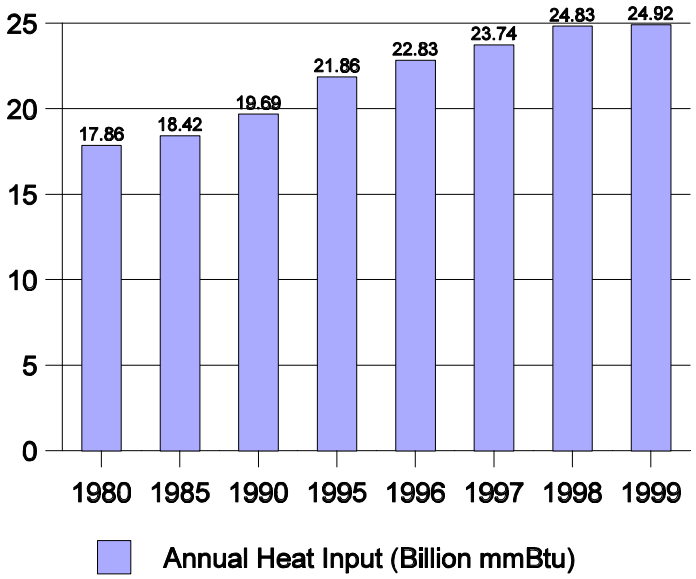
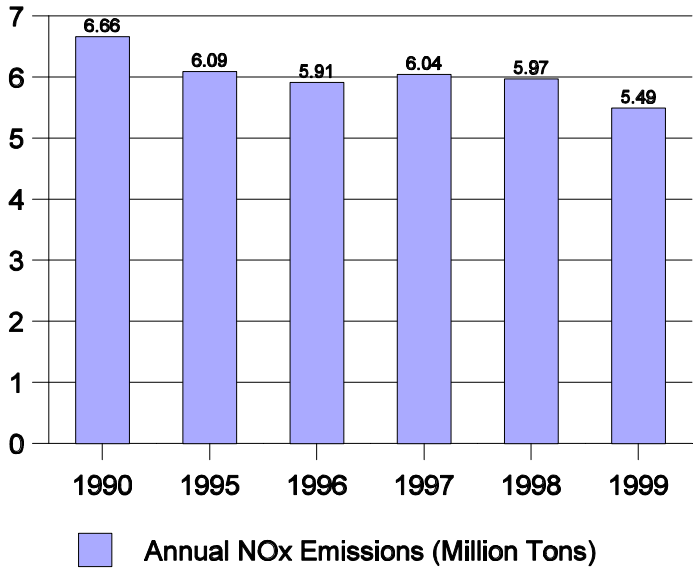


Figure 3 shows the trend in heat input (a measure of fuel burned to produce electricity) for all Title IV affected units. Based on the heat input trend illustrated in Figure 3, it appears that electricity production for all Title IV affected units increased by an average of 1.9% per year since 1980. From 1996 to 1997 the increase in heat input for electrical production averaged 4.0%, from 1997 to 1998, the heat input for electrical production averaged an increase of 4.6%. The heat input for electric production rose slightly in 1999 by only 0.36%.

Figure 4. *National NO_x Emissions from 1990, 1995 through 1999 for all Title IV Affected Units*



1996 was the first year Phase I units were required to limit their NO_x emission rates under the Acid Rain Program. National NO_x mass emissions declined by 570,000 tons from 1990 to 1995 and by an additional 180,000 tons from 1995 to 1996, despite the increase in heat input shown in Figure 3. In 1997, national NO_x mass emissions increased about 130,000 tons from 1996. There was a slight decline in national NO_X emissions in 1998 of about 70,000 tons. In 1999, there was a larger drop in NO_x emissions of about 480,000 tons. Figure 4 shows the estimated NO_x mass emissions for all Title IV affected units for 1990, 1995 through 1999.

Figure 5. *Average NO_x Emission Rate (lb/mmBtu) for 1990, 1996 through 1999 by Boiler Type for all Tangentially Fired and Wall-Fired Title IV Affected Units*

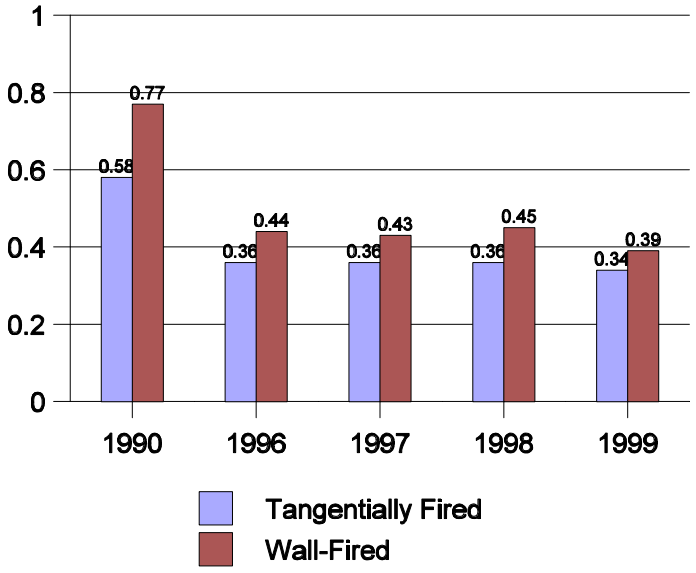
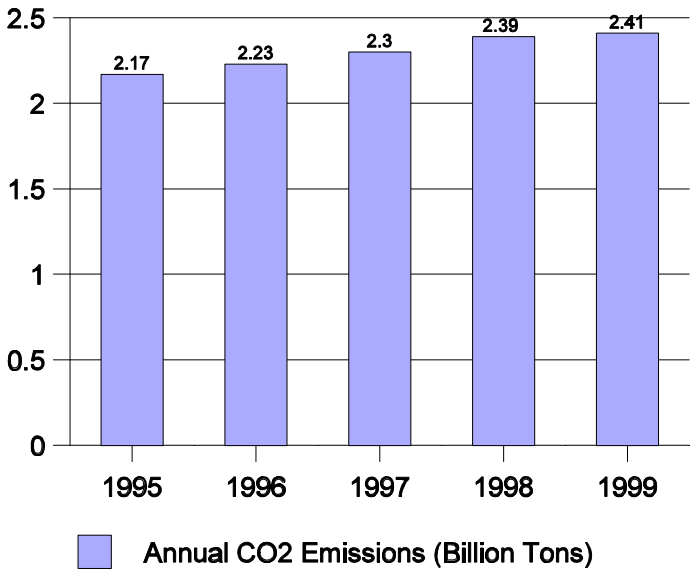


Figure 5 shows the 1990, 1996 through1999 heat input-weighted average NO_x emission rates for all units reporting to the Acid Rain Program, by boiler type. The 1999 average NO_x emission rates have slightly dropped from the 1998 average NOx emission rate for both tangentially-fired (633 units, 0.34 lb/mmBtu) and wall-fired units (891 units, 0.39 lb/mmBtu). These emission rates are below the required limits set for Phase I NO_x affected units of 0.45 and 0.50 lb/mmBtu.

Figure 6. *National CO_2 Emissions Trend for all Title IV Affected Units*



Title IV does not require control of CO_2 emissions; it only requires that they be measured and reported. As indicated in Figure 6, emissions of CO_2 from all Title IV affected units increased by 2.8% from 1995 to 1996 and by an additional 3.1% from 1996 to 1997. In 1998, CO_2 emissions increased by 3.9%. The CO2 emissions increased only by 0.84% in 1999.

Table 1. *National Totals of SO_2, NO_x, CO_2, and Heat Input for Coal Fired and Non-Coal Fired Title IV Affected Units for 1996 through 1999*

Pollutant/Heat Input	*Year*	Coal	Non-Coal	Total
SO_2 (Tons)	*1996*	12,105,081	408,782	12,513,863
	1997	12,511,081	467,046	12,978,127
	1998	12,418,073	715,629	13,133,702
	1999	***11,841,494***	***615,459***	***12,456,953***
NOx (Tons)	*1996*	5,541,584	386,768	5,908,352
	1997	5,616,471	426,189	6,042,660
	1998	5,407,999	564,983	5,972,982
	1999	***4,926,524***	***562,898***	***5,489,423***
CO_2 (Tons)	*1996*	2,010,972,798	220,460,260	2,231,533,058
	1997	2,064,871,688	238,520,194	2,303,391,882
	1998	2,089,966,620	296,476,404	2,386,443,025
	1999	***2,106,481,975***	***304,323,304***	***2,410,805,279***
Heat Input (mmBtu)	*1996*	19,510,824,887	3,315,745,968	22,826,570,855
	1997	20,092,477,956	3,647,002,918	23,739,480,874
	1998	20,322,825,091	4,502,796,846	24,825,621,937
	1999	***20,311,735,316***	***4,610,396,436***	***24,922,131,752***

Table 1 presents the 1996 through 1999 national total emissions and heat input data for all Title IV affected units, apportioned by two broad primary fuel type categories (coal or non-coal). The data reflect the predominance of coal use by U.S. facilities. Of the national totals in 1999, coal units account for 82% of the heat input, 95% of SO_2 emissions, 90% of NO_x emissions, and 87% of CO_2 emissions. Non-coal units affected by the Acid Rain Program include those that burn liquid or gaseous fossil fuel (oil, diesel, natural gas, etc.) or other solid fuel (two plants combusts wood) as their primary fuel.

Table 2. *SO_2 Emissions Breakdown by Program Participation of Units for 1996 through 1999*

	1996 SO_2		1997 SO_2		1998 SO_2		Final 1999 SO_2	
	# of Units	Emissions (tons)	# of Units	Emissions (tons)	# of Units	Emissions (tons)	# of Units	Emissions (tons)
Phase I, Table 1	263	4,765,251	263	4,769,415	263	4,659,524	263	4,348,230
Voluntary Phase I, Substitution, Compensating and Opt-In Units	168	668,100	160	705,017	145	638,953	135	596,435
TOTAL PIA	431	5,433,351	423	5,474,432	408	5,298,477	398	4,944,665
Phase II	1,473	7,080,512	1,458	7,503,695	1,572	7,835,225	1,576	7,512,288
Totals	1,904*	12,513,863	1,908*	12,978,127	1,943*	13,133,702	1974*	12,456,953

* Total number of units with emissions

Table 2 shows SO_2 emissions by three categories of units: 1) those 263 units required to participate beginning in 1995 (Phase I, table 1 units); 2) those units that were not affected by the program, but chose to participate (opt-in) or are Phase II units that chose to fall under the Phase I requirements (Phase I, voluntary participants: compensating or substitution units); and 3) those units not required to comply until 2000 (Phase II units). Phase I, Table 1 units continued to decrease SO_2 emissions by 6.68% between 1998 and 1999. The voluntary participants in Phase I units also had decreased emissions between 1998 and 1999 of approximately 42,500 tons. The Phase II units had increased emissions of 4.12%, between the same two years, resulting in ***total*** SO_2 emissions decreasing by 5.15% or 670,000 tons.

Table 3. *1999 SO_2, CO_2, NO_x, Emissions and Heat Trends Broken Down by Phase*

	# of Units	SO_2 (tons)	CO_2 (tons)	NOx (tons)	Heat Input (mmBtu)
Phase I, Table 1	**263**	**4,348,230**	**516,933,017**	**1,492,306**	**5,040,758,212**
Voluntary Phase I, Substitution, Compensating and Opt-In Units	**135**	**596,435**	**125,277,112**	**296,959**	**1,229,227,405**
TOTAL PIA	**398**	**4,944,665**	**642,210,129**	**1,789,265**	**6,269,985,617**
Phase II	**1576**	**7,512,288**	**1,768,595,151**	**3,700,158**	**18,652,146,136**
Totals	**1974***	**12,456,953**	**2,410,805,279**	**5,489,423**	**24,922,131,752**

* Total # of units with reported emissions

Table 3 shows the 1999 SO_2, CO_2, NO_x, emissions and heat input by three categories of units: 1) those 263 units required to participate beginning in 1995 (Phase I, table 1 units); 2) those units that were not affected by the program, but chose to participate (opt-in) or are Phase II units that chose to fall under the Phase I requirements (Phase I, voluntary participants: compensating or substitution units); and 3) those units not required to comply until 2000 (Phase II units).

Table 4. *Emissions Measurement Quality Assurance Measures*

Quality Assurance Measure	1995	1996	1997	1998	1999
Percentage of RATA test results indicating < 7.5% relative accuracy for pollutant monitors	94.5%	94.5%	96.0%	94.5%	93.1%
Median Relative Accuracy for pollutant monitors	3.22%	3.06%	3.27%	2.98%	3.21%
Percentage of RATA test results indicating < 10% relative accuracy for flow monitors	95.0%	95.8%	95.8%	97.3%	98.5%
Median Relative Accuracy for flow monitors	3.85%	3.54%	3.47%	3.52%	3.17%
Mean Annual Percent Monitor Availability	95.5%	96.7%	97.7%	97.7%	97.7%
Median Annual Percent Monitor Availability	98.4%	99.0%	99.2%	99.3%	99.3%
Number of Actual CEMS Used (except CO2)	4,364	4,149	4,185	4,562	5,434

Note: The RATA test results data were omitted where reporting errors occurred.

Table 3 summarizes the results for key emissions measurement quality assurance measures for 1995 through 1999.

Detailed Emissions Results for Acid Rain Program Affected Units

Detailed tabular results for the Acid Rain Program are presented in Appendices A and B. The following is a description of the contents of the Appendices.

Appendix A

Consists of two data tables: Table A1 and Table A2.

Table A1 presents the annual SO_2 emissions and heat input data for all Title IV affected units for the following years: 1980, 1985, 1990, 1997, 1998, and 1999. The data are ordered alphabetically, first by State name and then by plant name and unit id within each State. A unique numeric code used to identify each plant, known as the "ORISPL" code, is included in a column adjacent to the plant name. The column labeled "Unit ID" identifies the unit within the plant for which data are reported. The "Associated Stack" column identifies any stack or pipe associated with this unit.

The SO_2 and heat input data for each plant listed in Table A1 are displayed at the unit level, or "Unit ID", within the plant. In cases where different types of monitors are located at different sites within a plant or the connections between units and stacks are complicated, the data have been assimilated to the basic (unit) level for ease of presentation and comparison. In the case where a stack is fed by more than one unit, the stack is referred to as a "common stack" and is prefixed by "CS" in the "Associated Stack" column (the constituent units are listed in parentheses). A stack/unit arrangement where a stack is fed by more than one unit, any of which feeds another stack is called a "complex stack" and is prefixed by "XS" in the "Associated Stack" column (again, the constituent units are listed in parentheses). Analogous definitions apply to common fuel pipes ("CP" prefix) and complex fuel pipes ("XP" prefix). If a single unit feeds multiple stacks, the stack values are combined and listed at the unit level. Any ID listed in the "Associated Stack" column that does not contain any of the aforementioned prefixes refers to an individual unit.

Table A2 provides State-level summaries of the annual SO_2 and heat input data, for 1980, 1985, 1990, 1997, 1998, and 1999. The resulting national totals for those years are also presented at the end of the table.

Appendix B

Consists of four data tables: B1, B2, B3, and B4.

Table B1 presents the total annual 1999 SO_2, NO_x, CO_2, and heat input data for all Title IV affected units, along with additional descriptive information. The data are ordered alphabetically, first by state name and then by plant name and unit id within each state. A unique numeric code used to identify each plant, known as the "ORISPL" code, is included in a column adjacent to the plant name. The column labeled "Unit ID" identifies the unit within the plant for which data are reported. The various "Unit ID" definitions used in Table B1 are discussed below. The "Associated Stack" column identifies any stack or pipe associated with the unit.

The SO_2, NO_x, CO_2, and heat input data for each plant listed in Table B1 are displayed for the unit locations, or "Unit ID", within the plant. In cases where different types of monitors are located at different sites within a plant or the connections between units and stacks are complicated, the data have been assimilated to the basic (unit) level for ease of presentation and comparison. In the case where a stack is fed by more than one unit, the stack is referred to as a "common stack" and is prefixed by "CS" in the "Associated Stack" column (the constituent units are listed in parentheses). A stack/unit arrangement where a stack is fed by more than one unit, any of which feeds another stack is called a "complex stack" and is prefixed by "XS" in the "Associated Stack" column (again, the constituent units are listed in parentheses). Analogous definitions apply to common fuel pipes ("CP" prefix) and complex fuel pipes ("XP" prefix). If a single unit feeds multiple stacks, the stack values are combined and listed at the unit level. Any ID listed in the "Associated Stack" column that does not contain any of the aforementioned prefixes refers to an individual unit.

NOTE: Table B1 displays both the average NO_x emission rate (lb/mmBtu) and the NO_x mass emissions (tons). Under the Acid Rain Program facilities are only required to report the average NO_x emission rate. As a result, the NO_x mass emissions values contained in the table were calculated by weighting the hourly average NO_x emission rate (lb/mmBtu) by hourly heat input (mmBtu/hr) and the operating time, and then dividing by 2000 to convert the resulting value to tons.

Table B1 also contains seven columns that provide descriptive information (in a coded format) about each Unit ID listed. These columns are labeled "Status," "SO_2 Phase," "NO_x Phase," "Boiler Type," "Primary Fuel," "SO_2 Controls" and "NO_x Controls," and their associated codes are described below:

Status describes the operating status of each stack or unit. The status codes are defined as follows:

Blank	Operational (no permit exemptions), affected under Title IV
DF	Deferred unit, did not operate in 1999 (typically has been in long-term shutdown since before 1995), but is affected under Title IV
FU	Future unit (planned or under construction), will be affected under Title IV when operational
NO	Non-Operating unit, plant did not operate during 1999
N	New Non-exempt (new to the program and may not be operational – next stage beyond FU (future))
RE	Retired unit

SO_2 Phase describes the Acid Rain Program SO_2 "phase" classification for each stack or unit. The phase codes are defined as follows:

1	Phase I, Table 1 unit (263 units)
1.5	Phase I, Non-Table 1 unit (e.g., a Phase II unit that elected to become a Phase I substitution unit or compensating unit for a Table 1 unit as a compliance option in 1999, or a unit that opted-in to the program for 1999)
2	Phase II unit

NO_x Phase describes the Acid Rain Program NO_x "phase" classification for each stack or unit. The phase codes are defined as follows:

P1G1	Phase I, Group 1 unit (265 units)
P2EE	Phase II Early Election unit (274 units)

Boiler Type describes the type of boiler used as of the end of 1999 for the Unit ID. Boiler Type codes are defined as follow:

AF	Arch Fired	DVF	Dry bottom vertical-fired
C	Cyclone	O	Other
CB	Cell burner wall-fired	OB	Other boiler
CC	Combined Cycle	S	Stoker
CFB	Circulating fluidized bed	T	Tangential fired
CT	Combustion turbine	WBF	Wet bottom wall-fired
DB	Dry bottom wall-fired	WBT	Wet bottom turbo-fired
DTF	Dry bottom turbo-fired	WVF	Wet bottom vertical-fired

Primary Fuel describes the primary fuel used by each unit. The fuel types are:

C	Coal	NR	Primary fuel type was not reported for the Unit ID
D	Diesel	O	Oil
DSL	Diesel Oil	OOL	Other Oil
G	Gas	PNG	Pipeline Natural Gas

NNG	Natural Gas	W	Wood

SO_2 Controls describes the type of SO_2 control technology (scrubber), if any, reported as installed as of the end of 1999 for the Unit ID. Facilities employ these controls in order to assist or assure compliance with SO_2 emission requirements under the Acid Rain Program or other regulatory programs. The control codes are defined as follows:

DA	Dual alkali	SB	Sodium based
DL	Dry lime FGD (flue gas desulfurization)	U	Uncontrolled
FBL	Fluidized Bed Limestone Injection	WL	Wet lime FGD
MO	Magnesium Oxide	WLS	Wet limestone
NR	SO_2 not reported for Unit ID	Blank	No information reported for the Unit ID
O	Other		

NO_x Controls describes the type of NO_x control technology, if any, reported as installed as of the end of 1999 for the Unit ID. Facilities employ these controls in order to assist or assure compliance with NO_x emission requirements under the Acid Rain Program or other regulatory programs. The control codes are defined as follows:

CM	Combustion modification with fuel reburn	NH3	Ammonia Injection
DLNB	Dry Low NO_x Burners (Turbines Only)	NR	Not reported
H_2O	Water Injection (Turbines and Cyclone Boilers only)	O	Other
LNB	Low NO_x burner technology	OFA	Overfire air
LNBO	Low NO_x burner technology with overfire air	SCR	Selective catalytic reduction
LNCB	Low NO_x burner technology for cell burners	SNCR	Selective non-catalytic reduction

LNC1	Low NO_x burner technology with close-coupled OFA (Tangentially fired units only)	STM	Steam Injection
LNC2	Low NO_x burner technology with seperated OFA (Tangentially fired units only)	U	Uncontrolled
LNC3	Low NO_x burner technology with close-coupled and seperated OFA (Tangentially fired units only)	Blank	No information reported for the Unit ID

Table B2 provides Plant-Level summaries of the 1999 SO_2, NO_x, CO_2, and heat input data by state. The resulting totals for each plant are represented and state totals are represented after each state listing.

Table B3 provides State-level summaries of the 1999 SO_2, NO_x, CO_2, and heat input data for coal-fired units. The resulting national totals for coal-fired units is presented at the end of the table.

Table B4 provides State-level summaries of the 1999 SO_2, NO_x, CO_2, and heat input data for non-coal-fired units. The resulting national totals for non-coal-fired units is presented at the end of the table.